High-Intensity Precision Muonium Physics at Fermilab

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Muons, Inc.

for the collaboration:

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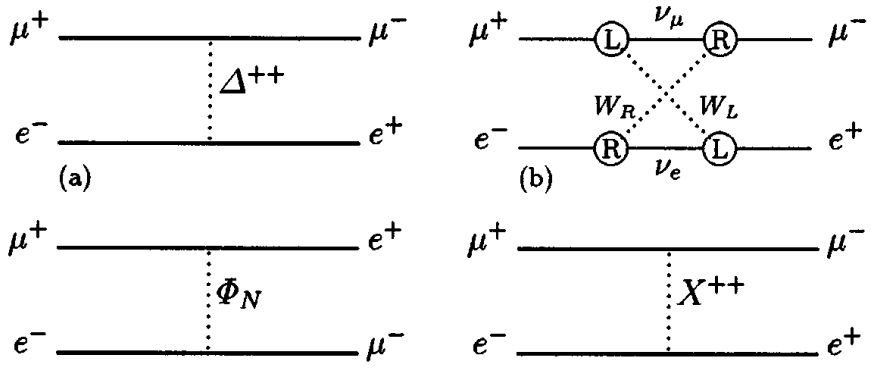
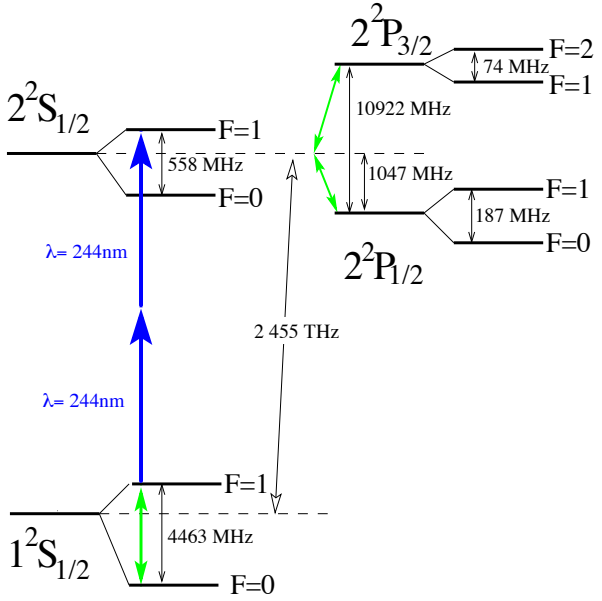
Muonium Physics Goals

- (**Muonium**: hydrogen-like μ^+e^- atom)
- **Muonium–antimuonium** (M-$\bar{\text{M}}$) **oscillations**: complementary to Mu2e — *differently* sensitive to CLFV new physics
  - *both* should be sought as sensitively as possible
- **Muonium spectroscopy**: atomic levels exquisitely predicted by QED (neither strong nor finite-size corrections)

  → clear windows for new physics
- **Muonium gravity**: "tabletop" experiment sensitive to possible 5th force
  - $g-2$, leptonic B, & W-mass anomalies → renewed interest
  - *only* way to test 2nd generation's gravitational coupling





Competitive Landscape

- **PSI**: world's most intense surface-muon beams
  - best previous M-$\bar{\text{M}}$ oscillation limit (MACS, 1999)
  - new M spectroscopy experiments:
    Mu-MASS (PSI, 1S-2S); MuSEUM (J-PARC, hyperfine)
    - together with $g-2$ → potential μ-only a value

- **HIMB** (PSI upgrade): goal x ≈ 30 rate increase
- **PIP-II** ("AMF"): potentially x ~10^2 over HIMB
- **In ≈ 10 years Fermilab could be *world's best* M physics venue!**
  - R&D opportunity <u>now</u> at existing "MTA" low-energy μ beamline @ Fermilab 400 MeV Linac
  - cost-effective few-M$, few-year program
- Collaboration formed, R&D program proposed